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ABSTRACT

Dutch children (ten five year olds and ten seven year olds) were asked to repeat two-clause sentences that varied in internal semantic cohesiveness. Results showed that semantic factors were primary in determining the five year olds' performance, while seven year olds, though possibly not insensitive to semantic variables, were retaining syntactic information about both high and low cohesion sentences. In a second experiment, 40 English children aged five or seven were asked to repeat variably cohesive sentences in which each of two clauses was, with respect to previously read material, either repetitious, informative, or irrelevant. Five year olds were shown to be more dependent on word order for semantic integration in that they performed best with a repetitious/informative model. Seven year olds could rapidly semantically integrate sentences with a variety of information structures. With regard to integration errors and first clause omissions, asymmetries appeared between the five and seven year olds which indicated that the former were more limited than the latter in the kind of information that was sufficiently rapidly integrated to allow for the appearance of over-integration errors. These results indicate that the developmental sequence in question is one in which the basic skill is the interpretation of utterances in their context. (JF)

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UNDERSTANDING SENTENCES IN CONTEXTS: SOME DEVELOPMENTAL STUDIES

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The successful interpretation of a spoken utterance, heard in a normal context, requires the listener to integrate together the semantic and syntactic information carried by the utterance itself, and simultaneously to relate this process to the preceding discourse context. The research described here investigates some developmental aspects of these processes, and it differs from most earlier developmental research in its emphasis on the immediate processing procedures involved. As a child listens to a connected discourse, how does he, clause-by-clause, interpret what he hears, and what kinds of intermediate representations does he construct as part of this process of interpretation? In particular, what is the relative importance at different ages of the syntactic, semantic and discourse structure of the material he hears?

Our earlier research in this area focussed on syntactic and semantic structural variables within a sentence, and showed developmental differences in the dominance of semantic rather than syntactic factors in the immediate recall of a sentence heard in a story context (Tyler and Marslen-Wilson, 1976). Children aged five, seven and 11 years listened to a story, and at unpredictable intervals the story was stopped and the children were asked to repeat back verbatim the last sentence they had heard. The five year old children differed from older children and adults (cf., Jarvella, 1971; Marslen-Wilson and Tyler, 1976) in the extent to which their recall was dominated by the syntactic structure of the two-clause test sentences. In particular, their recall did not show the double bow-shaped serial position curves (one for each clause) that are typical of adult performance and that were produced by the seven and 11 year olds. Instead, the pattern of their responses was best described by a single bow-shaped serial position curve covering the entire sentence.

This lack of clausal structuring of recall, together with the finding that the meaning of the original sentence was preserved suggested that the five year olds were responding on the basis of a unified semantic representation of the sentence as a whole. This claim was supported by the further finding that when the five year olds heard a syntactic prose story - which retained the syntactic structure of the original but was semantically uninterpretable - then clear clausal segmentation was observed. Thus it was not the case that the five year olds could not use syntactic structure to organise their recall, but rather that a syntactically-based clause-by-clause representation was rapidly superseded by a sentential semantic representation when such a level of representation was available. The seven and 11 year olds, although clearly also semantically interpreting and understanding the test-sentences,

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did not show this rapid loss of the clausal syntactic structure of the material.

The further research we report here will explore some of the implications of these results. The first experiment examines in more detail the within-sentence semantic factors controlling young children's immediate recall, while the second experiment goes on to examine the role of the informational relationship between the sentence and the discourse context in which it occurs.

Effects of Within-Sentence Semantic Cohesion

We drew the conclusion from the earlier experiment that what primarily determined the organisation of the five year olds' immediate representation of a sentence was its semantic rather than its syntactic properties. This implies that the extent to which a two-clause sentence is recalled as two separate units or as a single unit will depend on the degree to which the two clauses of the sentence can be semantically integrated into a single unit. In other words, the structure of recall should reflect the semantic cohesiveness between different parts of the sentence.

Thus for the first experiment we constructed a set of 20 two-clause test-sentences, embedded in a short story, that varied in their internal semantic cohesiveness. Ten of the sentences (High Cohesion sentences) were ones in which the agent and patient were the same in both clauses, and where the actions in each clause were closely related and usually part of the same general event. For example:

- 1) Sarah went running up to Peter and gave him a big hug.
- The other ten test-sentences were Low Cohesion sentences, in which the agents, patients and actions in each clause were different and, as far as possible, different events were involved. For example:
- 2) When the children were at school Sarah and Peter visited their friends.

Note that these sentences occurred in the context of a story, so that the extent to which the clauses within a sentence were related was also partly a function of the story structure which was available when the child heard that sentence. A further consequence of the fact that the sentences were not presented in isolation was that it was not possible to construct, for example, Low Cohesion sentences in which each clause described totally unrelated events, for then the sentence would have been anomalous in its context. Thus our ability to construct sentences which were clearly High or Low Cohesion was constrained by the fact that each sentence had to be consistent with the prior discourse. We were, therefore, manipulating relative degrees of cohesiveness, rather than constructing all-or-none contrasts.

As in the previous experiment the story was presented over headphones and the child was asked to repeat back the last sentence heard. Twenty Dutch children served as subjects, of whom 10 were five year olds and 10 were seven year olds.² Both age-groups heard similar materials, the only difference being that the seven year

FIG 1: 5 YEAR OLD HIGH CONSTRAINT DATA WITH 95% CONFIDENCE LIMITS

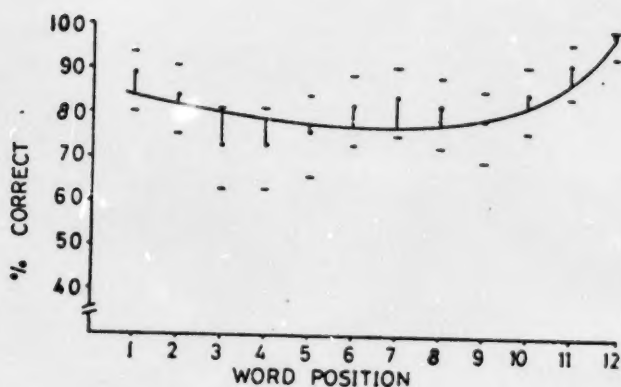
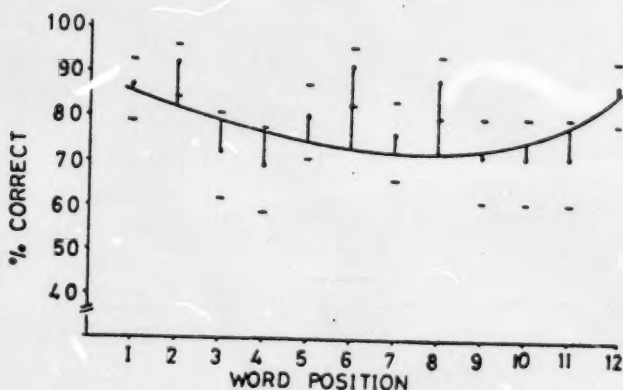


FIG 2: 5 YEAR OLD LOW CONSTRAINT DATA WITH 95% CONFIDENCE LIMITS



olds heard 14-word rather than 12-word sentences. Each word of the children's responses was scored as either correct or incorrect depending on whether or not it was an exact reproduction of the word in the original sentence. The combined scores for all subjects in each age-group were then plotted as a function of word-position.

Our major hypothesis was that the five year olds' serial position curves should show more evidence of clausal organisation for the Low Cohesion sentences than for the High Cohesion sentences. Whereas the seven year olds should show the same clausally organised pattern for both types of sentences, since their immediate recall is less dependent on semantic factors alone. This means that for the five year olds a second-order (quadratic) curve spanning the entire sentence should provide a better description of the High Cohesion recall scores than should a fourth-order curve made up of two second-order curves (that is, one separate quadratic curve for each clause). In contrast, for the Low Cohesion sentences, we predicted that the fourth-order curve would provide the best description of the five year old data.

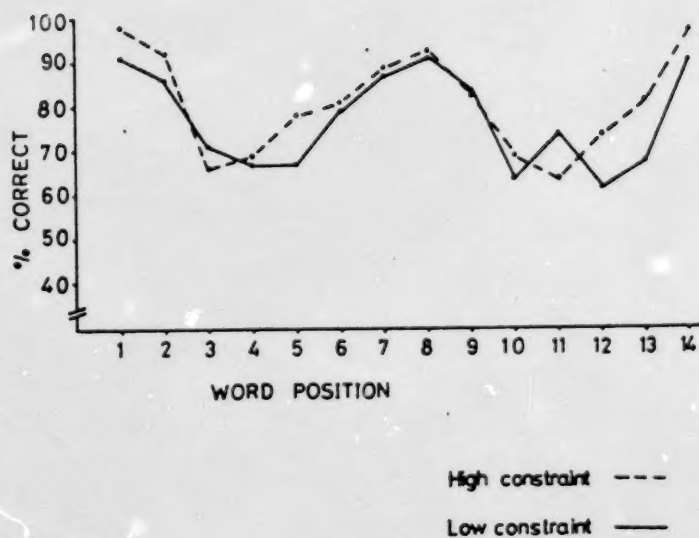
Figure 1 shows the five year old High Cohesion data with 95% confidence limits plotted for each data point. Remaining within these confidence limits a second-order quadratic curve can be drawn across the entire sentence, with only minor residuals. Although a fourth-order curve can be fitted to these data, the second-order curve accounts for four times more of the variance than does the fourth-order curve.

Figure 2 shows the five year old Low Cohesion data with 95% confidence limits similarly plotted for each data point. Here a single second-order curve does not fall within the 95% confidence limits for all the data points. Furthermore, the large residuals are clearly distributed in such a way that they indicate that a fourth-order fit is required. A statistical analysis showed that the fourth-order fit is indeed significantly better than the second-order fit. These differences in the curves are not simply due to the ease of recall of the two types of sentences, for the overall percent correctly recalled was similar for High Cohesion (84%) and Low Cohesion (80%) sentences.

In contrast, the two sets of recall curves for the seven year olds were almost identical. The form of both the High and Low Cohesion curves was dominated by the clausal syntactic structure of the sentences, and in both cases a fourth-order curve provided the only statistically significant fit to the data (Fig. 3).

This difference between the five and seven year old recall curves was exactly what we expected to find, given our original hypothesis. Semantic factors are primary in determining the five year olds' performance in this task, and do not seem to affect the seven year olds. But this conclusion is, in itself, somewhat unsatisfactory. In particular, we do not want to have to claim that seven year olds are doing less semantic processing than five year olds. The shape of the seven year olds' recall curves shows that they are retaining syntactic information about both the High

FIG 3: 7 YEAR OLD HIGH AND LOW
CONSTRAINT DATA



and Low Cohesion sentences, but that does not necessarily mean that they are insensitive to semantic variables.

But just looking at the shape of the recall curves is not going to resolve this kind of question, nor, in general, is it going to tell us about the qualitative similarities and dissimilarities in semantic processing at different ages. To get at this kind of information we need to look at children's performance in this type of task in a way which can tell us more directly about how sentences are being semantically interpreted as they are heard in a story context. This leads us not only to a different kind of analysis of the children's responses in the task, but also requires that we take a closer look at the relationship between the test-sentences and their discourse contexts.

Effects of Textual Cohesion on Sentence Interpretation

This part of the research focuses on the possible developmental differences in the ways in which a child's interpretation of a sentence is affected by the kind of textual relationship that holds between the sentence and its discourse context. We have shown that the five year olds are more affected than seven year olds by semantic cohesion within a sentence. The questions now are, firstly, whether five and seven year old children are also differentially sensitive to the discourse factors determining the textual cohesion of a sentence, and, secondly, whether by looking at this aspect of their performance we can obtain a clearer picture about semantic integration processes in seven year olds.

We found that we could obtain relatively direct access to the processes involved in textual integration by analysing the errors made in the clause memory task in terms of the integrative processes that we needed to postulate in order to explain the errors. But to do this we first had to classify the test-sentences according to their textual cohesiveness, while still controlling their internal cohesiveness (High and Low Cohesion).

After some trial and error, and study of the previous test materials, we classified a group of test sentences, clause-by-clause, along two textual dimensions. First, according to whether the clause carried information about an event already in progress in the prior text (i.e. "Same event" category) or whether it introduced a new event. Secondly, whether the clause carried new or old information about the event to which it belonged. This gave us three categories, labelled as follows:

- 1) Same event/Old information = Redundant
- 2) Same event/New information = NonRedundant
- 3) New event/New information = New

The fourth possibility - of New event and Old information - did not occur.

We then applied these categories to a group of 20 test sentences embedded in a story context, which also varied in their internal cohesiveness in the way previously described. 40 English children (20 five year olds, and 20 seven year olds) were tested on this material, again using the clause memory task.¹ We will report here

only the results of the error analysis.

These analyses showed that the five and seven year olds were performing overall in similar ways, and were sensitive to the same variables during sentence processing and recall. However, it was also clear that the five year olds were more sensitive to certain aspects of the input. In particular, it seemed that for the five year olds to rapidly semantically integrate the input - both within a sentence and with the prior context - they were dependent upon a particular order of information. That is, semantic integration was greatly facilitated when the first clause of the test sentence contained old information and described the same event as in the prior context, and when the second clause contained new information about that same event (i.e. Redundant/NonRedundant). In contrast, the seven year olds could rapidly semantically integrate sentences with a variety of information structures. The analyses of three different types of errors lead to these conclusions.

Integration errors. Both age-groups made a similar number of integration errors. These included both errors of fusion, where part of the prior discourse was integrated into the sentence being recalled, and errors based on inference. In the inference errors, a change was made in the original which could only be interpreted as the result of an inference either from the meaning of the two clauses taken together or from an integration between the sentence and the prior discourse. These, then, are errors of over-integration, as it were, where the children fail to recall the test-sentence with verbatim accuracy because, apparently, the process of integrating the test-sentence with the preceding text has been taken so far that the original format of the input can no longer be reconstructed. As such, these errors directly reflect the rapidity with which sentences and clauses of different types are integrated into the preceding discourse. And it is here that we find the clearest differences between age-groups.

When the integrative errors were broken down according to whether the error occurred in a clause classified as Redundant, NonRedundant or New, it was clear that a large proportion of the five year olds' errors were located in the Redundant clauses (65%), whereas hardly any occurred in New clauses (3%). However, the integrative errors in the seven year olds' recall were much more evenly distributed amongst the three categories - with 45% in Redundant clauses, 33% in NonRedundant clauses and 21% in New clauses.

The integrative errors were also analysed as a function of the "event structure" of the entire sentence, and these results are shown in Table 1.

There are clear asymmetries between the five and seven year olds, with the five year olds making a much larger percentage of their errors in the Same event/Same event sentences than in any other category. Also, most of the errors within this category (67%) were located in Redundant/NonRedundant sentences. Although the seven year olds also made many errors in the Same event/Same event sentences, the proportion was smaller than for the five year olds. Furthermore,

unlike the five year olds, they make a large percentage of errors in the New event sentences.

Table 1: Integration errors and event structure.

Event structure		Age	
Clause 1	Clause 2	5 years	7 years
Same event	Same event	73%	52%
Same event	New event	19%	15%
New event	New or Same event	8%	33%

Thus, analyses of the integrative errors, both as a function of the properties of the clause involved, and as a function of the event structure of the sentence in which the error occurred, showed that the five year olds were rapidly semantically integrating the input when they could - but that they were more limited than the seven year olds in the kind of information which was sufficiently rapidly integrated to allow for the appearance of over-integration errors. That is, they required a particular kind of input where the event which was current in the text was maintained in the test sentence (in particular, the Redundant/NonRedundant case). This restriction, however, did not apply as strongly to the seven year olds.

A breakdown of the integrative errors according to the internal cohesion of the sentence involved (High vs Low Cohesion) is also consistent with this kind of interpretation. As Table 2 shows, both age-groups made more integration errors in High than in Low Cohesion sentences, but the difference was more marked for the five year olds.

Table 2: Integration errors as a function of internal cohesion

Internal Cohesion	Age	
	5 years	7 years
High Cohesion	81%	64%
Low Cohesion	19%	36%

Furthermore, all of the Low Cohesion integrative errors made by the five year olds occurred in Redundant/NonRedundant (Same event) sentences - as if the cohesiveness of the sentence with the text was overriding the lack of cohesiveness of the two clauses with each other. The seven year olds, on the other hand, were just as likely to make Low Cohesion integration errors in New event sentences as in Same event sentences.

First clause omissions. The interpretation so far is also supported by the analysis of a different kind of error -- cases in which the children omitted the first clause completely, and began their recall at the beginning of the second clause. Table 3 shows the analysis of the distribution of first clause omissions as a function of the location of what can be called "event boundaries" in the test sentences. That is, whether the test sentence included a shift from one event to another.

Table 3: First clause omissions and event boundaries.

Location of event boundary in sentence	Age		Chance
	5 years	7 years	
No boundary	13%	19%	45%
Beginning	18%	19%	40%
Middle	69%	62%	15%

Overall, five and seven year olds show exactly the same pattern. Two-thirds of the first clause omissions occur in cases where there is an event boundary in the middle of the sentence, so that the first clause belongs to a separate event from the second clause. If these errors were distributed according to chance, we would expect many more omissions in sentences containing no event boundaries or beginning with an event boundary, and many fewer in those with a mid-sentence event boundary.

If, therefore, we interpret first clause omissions as reflecting the complete integration of the first clause into the representation of the preceding discourse, so that it is no longer available as a separate unit for recall, then it is instructive to look at the discourse structure of the test sentences involved. Table 4 shows this breakdown for the mid-sentence event-boundary cases. Here we

Table 4: First clause omissions and discourse structure

Textual properties of test sentences	Age	
	5 years	7 years
NonRedundant/New	19%	39%
New/New	22%	26%
Redundant/New	59%	35%

see the same kind of difference between the five and seven year olds as in the integrative errors. Seven year old omissions are evenly distributed over the three types of sentence with an event boundary

in the middle, while the five year old's omissions occur twice as often in the Redundant/New sequences as in either of the other two cases.

In other words, five year olds are most likely to "lose" a clause when it is not only a "same event" clause, but also when it contains old information -- and therefore is maximally integratable with the preceding discourse. The seven year olds, however, "lose" first clauses just as often when they are "same event/new information" clauses or even "new event" clauses.

Meaning-changing errors. The third kind of error that was analysed consisted of cases in which the children made meaning-changing errors, so that their recall seriously diverged from the meaning of the original.

Here we find the smallest differences between age-groups. Overall they make the same number of meaning-changing errors, and they show a similar breakdown according to internal cohesiveness -- with many fewer errors occurring in the High Cohesion sentences. As Table 5

Table 5: Meaning changing errors and internal cohesion.

Internal Cohesion	Age	
	5 years	7 years
High Cohesion	4%	22%
Low Cohesion	96%	78%

shows, there is a slight tendency for the 5 year olds to be more sensitive to the Low Cohesion/High Cohesion distinction. They make practically no errors at all in High Cohesion sentences.

Table 6: Meaning-changing errors as a function of clause type.

Textual properties of clause containing error	Age	
	5 years	7 years
Redundant	23%	22%
NonRedundant	15%	17%
New	62%	61%

Table 6 shows the interaction between meaning-changing errors and the textual properties of the clauses in which they occur. This type of error occurs predominantly in New event clauses, and much less frequently in Same event clauses (irrespective of whether they contain new or old information). Both age groups show exactly the same pattern, which reinforces the claim that the five and seven year olds are performing overall in the same way. The differences we see are differences in degree only, and they are not differences

in the extent to which the two groups can correctly understand the material they hear. Where, for both groups, their understanding does tend to break down is, predictably, at the points of greatest discontinuity in the text. That is, when a new event is being introduced, so that what is known about the story up to that point provides the weakest guidelines for the interpretation of the sentence being heard.

Thus, the earlier evidence, from the analysis of the integration and omission errors, showed that the seven year olds' interpretation of the input was less impeded than the five year olds' by the introduction of new events or new information about old events. The evidence from the meaning-changing errors shows that these discourse variables were, nonetheless, a significant factor in the seven year olds' performance. For when they did make errors of interpretation, the distribution of these errors was determined in the same way as for the five year olds by the textual relationship between the context and the clause containing the error.

Conclusions

We need to consider first the relationship between the second experiment reported here and the age differences in the effects of sentence-internal semantic cohesion described earlier. It now seems plausible that the differences in the textual cohesiveness of the High and Low Cohesion sentences could be sufficient to account for the differences in the degree to which the five year olds clausally structured their recall of these two types of material.

For Low Cohesion sentences are much more likely to contain New clauses, especially in the second clause position. And, as the second experiment shows, it is precisely these kinds of clauses that the five year olds do not rapidly integrate, either within the sentence or between the sentence and the discourse. High Cohesion sentences, on the other hand, are predominantly "same-event" sentences, which five year olds can and do rapidly textually integrate. In the second experiment, textual differences of this type affected the distribution of integration and clause-omission errors. In the first experiment, such differences would lead to a greater clausal structuring of Low rather than High Cohesion sentences, as reflected in the shape of the five year olds' serial position curves.

The seven year olds, in contrast, were shown in the second experiment to be less slowed down in their processing by variations in the textual properties of the test-sentences. Thus, if we just consider the textual cohesiveness of the High and Low Cohesion sentences, we would not expect to find differences in the way in which the older children structure their recall of either type of sentence.

This re-interpretation of the internal cohesion effects in terms of textual cohesion variables does not by itself, however, explain the age-differences we find in both experiments here, and in the earlier study (Tyler and Marslen-Wilson, 1978). In this earlier study, we had suggested that the age-differences we found in the Jarvella task were ultimately due to differences in "processing capacity". The five year olds, we proposed, were more limited in

this respect, and therefore were under greater pressure to recode the input into a higher level of representation. This would mean, compared with older children, that they would more rapidly lose information about the lower-level properties of the input. In interpreting the present studies we need to invoke a similar basic explanation of how the five and seven year olds differ. But what we can now add to this explanation is a more specific account of where these processing difficulties have their effect.

Taking these three studies together, it becomes clear that the developmental sequence we have been dealing with is one in which the developmentally basic skill is the interpretation of utterances in their contexts. What we see developing is apparently both an increase in processing "capacity" and in processing "skills" (we leave aside here the issue of how far "capacity" and "skill" are in fact functionally distinguishable). The effect of this dual development is to allow the older children both to rapidly process textually more demanding inputs, and to maintain for longer in memory some information about the intermediate stages of the interpretation process. The younger children are not performing in a qualitatively different manner, but they are forced by their less developed capacities to move as rapidly as possible to the functionally basic goal of normal listening -- to interpret the utterance in its context. It is likely that if we were to move still further back in the developmental sequence we would find increasing dominance of these context-based interpretative functions, and still less control over the putative syntactic and semantic subcomponents of these processes.

Footnotes

1. LKT is now at: Interfacultaire Werkgroep Taal- en Spraakgedrag, Katholieke Universiteit, Berg en Dalseweg 79, Nijmegen, The Netherlands. This research was supported in part by a grant to LKT from Nederlandse Organisatie voor zuiver-wetenschappelijk onderzoek.
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